CLAIMS

We claim

1. A multi-level waveguide comprising:

a first substrate having a first opening therethrough;

a second substrate, attached to said first substrate, having a second opening therethrough and aligned with the first opening in said first substrate;

a transparent material inserted in said first substrate hole; and

a transparent material inserted in said second substrate hole.

2. The multi-level waveguide of claim 1, wherein said transparent material is a gas.

3. The multi-level waveguide of claim 1, wherein said transparent material is cladding grown on the inside of the substrate hole.

4. The multi-level waveguide of claim 1, wherein said transparent material is comprised of an outer cladding and a separate inner transparent material.

5. The multi-level waveguide of claim 1, wherein said transparent material is an optical fiber.

6. The multi-level waveguide of claim 1, wherein said first substrate is made of silicon.

7. The multi-level waveguide of claim 1, wherein said transparent material and said first substrate are made of the same material.

8. The multi-level waveguide of claim 1 further comprising a source of electromagnetic radiation attached to said first substrate.

9. The multi-level waveguide of claim 1 further comprising a detector of electromagnetic radiation attached to said second substrate.

10. The multi-level waveguide of claim 1 further comprising a conductive layer on said second substrate.

11. A method of making a multi-level waveguide comprising:

etching a hole in a first substrate;

etching a hole in a second substrate;

lithographically aligning said first substrate hole to said second substrate hole; and

attaching said first substrate to a second substrate.

12. The method of claim 11 further comprising growing a cladding in said first substrate hole before lithographically aligning said first substrate hole to said second substrate hole

13. The method of claim 11, further comprising:

radially growing a cladding on walls of said first substrate hole to a depth less than the first substrate hole's radius; and

inserting transparent material having an index of refraction greater than an index of refraction of the cladding material into said first substrate hole before lithographically aligning said first substrate hole to said second substrate hole.

14. The method of claim 11, wherein said aligning comprises:

placing a solder bump on said first substrate relative to said first substrate hole;

placing a metal pad on said second substrate relative to said second substrate hole;

moving said first substrate and said second substrate relative to each other to contact said solder bump to said metal pad; and

melting said solder bump to said metal pad.

15. The method of claim 11, wherein said aligning comprises:

etching a marker hole in said first substrate relative to said first substrate hole;

etching a marker hole in said second substrate relative to said second substrate hole;

moving said first substrate and said second substrate relative to each other until a source of electromagnetic radiation radiates through said first substrate marker hole and said second substrate marker hole; and

detecting said source of electromagnetic radiation with a detector of electromagnetic radiation.

16. The method of claim 11 further comprising applying conductive layers on said first substrate.

17. A multi-level waveguide comprising:

a first substrate having a first opening therethrough;

a substantially horizontal core pathway on top of said first substrate; and

a cladding layer on top of said core pathway.

18. The multi-level waveguide of claim 17, wherein a layer of cladding is between said first substrate and said horizontal core pathway.

19. The multi-level waveguide of claim 17, further comprising a marker on said first substrate

20. A method of making a multi-level waveguide comprising:

depositing core material on a first substrate;

patterning said core material with a mask;

etching said patterned core material; and

depositing a cladding layer on said core material.

21. The method of claim 20 further comprising depositing a layer of cladding on said first substrate before depositing said core material.

22. The method of claim 20 further comprising etching a hole in said first substrate.

23. The method of claim 20 further comprising:

etching a hole in a second substrate;

aligning said first substrate hole to said second substrate hole; and

attaching said first substrate to said second substrate.

24. A method of making a multi-level waveguide comprising:

etching a hole in a first substrate;

etching a hole in a second substrate;

heating said first substrate;

inserting an optical fiber into said first substrate hole;

lithographically aligning said first substrate to said second substrate; and

attaching said first substrate to said second substrate.

25. The method of claim 24, wherein said first substrate is heated to a temperature between approximately 75° C and 175° C.

26. The method of claim 24 further comprising applying a conductive layer to said second substrate.

27. The method of claim 24, wherein said aligning comprises:

placing a solder bump on said first substrate relative to said first substrate hole;

placing a metal pad on said second substrate relative to said second substrate hole;

moving said first substrate and said second substrate relative to each other to contact said solder bump to said metal pad; and

melting said solder bump to said metal pad.

28. The method of claim 24, wherein said aligning comprises:

placing a solder bump on said first substrate relative to a first substrate optical fiber core;

placing a metal pad on said second substrate relative to a second substrate optical fiber core;

moving said first substrate and second substrate relative to each other to contact said solder bump to said metal pad; and

melting said solder bump to said metal pad.

29. The method of claim 24, wherein said aligning comprises

etching a marker hole in said first substrate relative to at said first substrate hole;

etching a marker hole in said second substrate relative to said second substrate hole;

moving said first substrate and said second substrate relative to each other until a source of electromagnetic radiation radiates through said first substrate marker hole and said second substrate marker hole; and

detecting said source of electromagnetic radiation with a detector of electromagnetic radiation.

30. The method of claim 24, wherein said aligning comprises

etching a marker hole in said first substrate relative to a first substrate optic fiber core;

etching a marker hole in said second substrate relative to a second substrate optic fiber core;

moving said first substrate and said second substrate relative to each other until a source of electromagnetic radiation radiates through said first substrate marker hole and said second substrate marker hole; and

detecting said source of electromagnetic radiation with a detector of electromagnetic radiation.